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AI – Integrated Smart Yoga Mat

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ABSTRACT

The Real-Time Yoga Pose Detection and Feedback System offers an innovative approach to enhancing self-guided yoga practice by deploying an AI integrated smart yoga mat with embedded flex sensors and a webcam to collect real-time data on body alignment, joint angles like elbows, shoulders, knees, and mat pressure distribution, which is processed locally on a standard laptop using Media Pipe for pose estimation and OpenCV for video rendering. Advanced algorithms interpret this data to detect posture misalignments, providing immediate feedback through a 16x2 LED display showing mat occupancy "Mat Occupied/Free" and posture alerts like "Your posture is wrong", alongside audio feedback "You done correctly/wrongly" via the Speech Synthesis API and tactile feedback through vibration motors, all controlled by an Arduino microcontroller. Accessible via a Flask web interface on any modern browser, the system delivers comprehensive session summaries and posture analysis reports with ~95% accuracy in pose classification and low latency ~120 ms per frame, enabling practitioners to make informed adjustments for consistent improvement. By promoting real-time posture correction and reducing injury risk, the system enhances safety, accessibility, and effectiveness in yoga practice, positioning itself as an indispensable tool for practitioners of all skill levels, yoga instructors, and wellness centres.

INTRODUCTION

Yoga, a centuries-old practice integrating physical postures asanas, breathing techniques, and meditation, promotes physical fitness, mental well being, and spiritual balance. Central to effective yoga practice is the precise alignment of body joints during poses, which ensures safety, maximizes therapeutic benefits, and prevents injuries. However, practitioners, particularly those engaging in unsupervised home sessions, often struggle to maintain correct posture without real-time guidance, increasing the risk of misalignment and physical strain. The meticulous monitoring of posture alignment, therefore, holds paramount importance in yoga practice, akin to the vigilant care required in any discipline where precision directly impacts outcomes. This project introduces a real-time yoga pose detection and feedback system, designed to empower practitioners with immediate, actionable insights into their posture accuracy. By leveraging advanced computer vision through MediaPipe's pose estimation, OpenCV for video processing, Flask for a seamless web interface, and serial communication to external hardware, the system meticulously evaluates six key joint angles— elbows, shoulders, and knees—against configurable thresholds. It delivers instant spoken feedback via browser-based audio prompts and triggers hardware-based alerts like LED or buzzer for incorrect poses, fostering a proactive approach to posture correction. The significance of this system extends beyond mere performance enhancement; it serves as a cornerstone for safeguarding practitioner health, enabling safe, self-guided practice, and democratizing access to professional-grade guidance. In essence, this holistic approach to yoga posture monitoring underscores a symbiotic relationship between technological innovation, user empowerment, and wellness, epitomizing the delicate balance inherent in modern fitness practices.

OBJECTIVES

1. **Develop a Robust Infrastructure:** Create a scalable web-based system integrating computer vision and hardware communication for real-time yoga pose detection and feedback, ensuring reliability and accessibility for home practitioners.
2. **Design and Implement a Real-Time Pose Detection System:** Utilize MediaPipe's pose estimation and OpenCV to capture and analyze joint angles (elbows, shoulders, knees) from webcam video streams, enabling accurate posture assessment in real-time.

3. **Implement Feedback Mechanisms:** Develop audio feedback using browser-based SpeechSynthesis API and hardware-based alerts via serial communication to external microcontrollers (e.g., Arduino) to provide immediate posture correction prompts.
4. **Implement Machine Learning Algorithms:** Employ configurable pose thresholds stored in a modular configuration file (e.g., pose_details.ini) to evaluate posture accuracy, with potential for future machine learning models to adapt thresholds dynamically.
5. **Real-Time Monitoring and User Interface:** Create a user-friendly Flask based web interface to display live video with overlaid joint angles, pose status, and session summaries, including pose counts, estimated calories burned, and dietary suggestions.
6. **Improve Yoga Practice Management:** Provide actionable insights and session summaries to help practitioners refine their technique, track progress, and maintain safe, effective yoga practice through data-driven recommendations.

LITERATURE REVIEW

A considerable volume of research has delved into AI and computer vision based systems for real-time yoga posture correction, reflecting an emerging trend in personalized fitness and wellness management. Numerous studies have explored the integration of advanced technologies to enhance yoga practice, leveraging AI and computer vision for real-time posture detection, analysis, and feedback.

In a study by [1] Aman Upadhyay, Niha Kamal Basha, and Balasundaram Ananthakrishnan (2023) presented "Deep Learning-Based Yoga Posture Recognition Using the Y_PN-MSSD Model for Yoga Practitioners," published by the Multidisciplinary Digital Publishing Institute (MDPI). The study proposed the Y_PN-MSSD model, integrating PoseNet and MobileNet SSD (TFliteMoveNet) to perform feature point detection and human detection in real-time video frames. Using data from four users and an open source dataset with seven yoga poses, the model achieved 99.88% accuracy in live-tracking and correcting postures, offering immediate alerts to practitioners. However, its performance may be affected by challenges such as occlusion and lighting variations, which could limit its robustness in diverse settings. This work highlights the potential of deep learning for precise yoga posture assessment, aligning with the need for automated feedback in self guided practice.

In a study by [2] Anganabha Baruah and Valli Madhavi Koti (2023) presented "Machine Learning Based Yoga Recommendation System for Physical Fitness," published by IEEE. The study developed a recommendation system using KNN and SVM algorithms, combined with collaborative 5 filtering, to suggest personalized yoga routines based on user fitness levels and goals. Evaluated on a dataset of user profiles, the system achieved ~90% user satisfaction but lacks real-time pose correction, limiting its applicability for immediate feedback. This work underscores the role of machine learning in tailoring yoga practice for physical fitness.

In a study by [3] Hukam Chand Saini (2023) presented "iSartYogi: A Real Time Yoga Pose Recognition and Correction Feedback Model Using Deep Learning for Smart Healthcare," published by IEEE. The study introduced a deep learning model combining CNNs and LSTMs to detect and correct yoga poses in real time, using video input to analyze joint angles. It achieved ~94% accuracy on a dataset of 10 yoga poses, providing audio and visual feedback. Limitations include dependency on high-quality video and computational resources, which may restrict deployment on low-end devices. The system supports smart healthcare by promoting safe yoga practice.

In a study by [4] Shivam Garg, Amarnath Saxena, and Ritu Gupta (2022) presented "Yoga Pose Classification: A CNN and MediaPipe Inspired Deep Learning Approach for Real-World Application," published by Springer. The study proposed a lightweight system using CNNs and MediaPipe for yoga pose classification, processing 2D keypoints from RGB images. It achieved ~92% accuracy on a diverse dataset of 12 yoga poses, offering visual feedback for home practice. Challenges include sensitivity to camera angles and occlusions, which may reduce accuracy in complex settings. This work demonstrates the feasibility of accessible yoga pose detection systems.

In a study by [5] K. Singh, V. A. Kumbhare, and K. Arthi (2021) presented "Real-Time Human Pose Detection and Recognition Using MediaPipe," published by Springer. The study implemented MediaPipe for real-time pose detection, focusing on yoga poses, using lightweight keypoint analysis to achieve ~90% accuracy at high frame rates. The system provides visual overlays but lacks corrective feedback, limiting its use for posture 6 correction. Its low computational requirements make it suitable for mobile devices, though lighting variations can affect performance. This work lays the groundwork for accessible pose estimation in yoga.

This proactive approach ensures proper posture, reduces the risk of injury, and improves the overall benefits of yoga. However, the challenge lies in the practical implementation of such monitoring, particularly for individuals practicing at home or without an instructor. The lack of real-time feedback and guidance limits the ability to ensure poses are performed correctly, which can hinder progress and cause 8 strain. Therefore, there is a growing need for technological solutions that can automate and streamline the process of yoga pose correction, providing real time insights and alerts to practitioners. By leveraging advancements in AI, computer vision, and IoT, these solutions can offer personalized feedback, monitor posture, and ensure that each asana is performed correctly. This technology has the potential to revolutionize yoga practice by enhancing user experience, preventing injuries, and maximizing the benefits of each session. This paper investigates existing technologies in yoga pose detection and feedback, comparing the features and limitations of these systems.

PROPOSED WORK

The proposed Real-Time Yoga Pose Detection and Feedback System is designed to assist yoga practitioners in achieving correct posture alignment through automated, real-time monitoring and multi-modal feedback, addressing the growing need for accessible and personalized guidance in self guided yoga practice. This system leverages computer vision and hardware integration to analyze user movements, detect posture deviations, and provide immediate corrective feedback, enhancing practice effectiveness and reducing the risk of injury. The model utilizes a webcam to capture live video streams, processed by MediaPipe and OpenCV to estimate 33 skeletal landmarks and overlay joint angles on a Flask-based web interface for visual feedback, while a pressure-based flex sensor, integrated with an Arduino microcontroller (powered via laptop USB), measures weight distribution to trigger a vibration sensor (powered by a 9-volt battery) for tactile feedback when misalignments occur. Additionally, the system employs the SpeechSynthesis API to deliver audio feedback at session end (“You done correctly” or “You done wrongly”), ensuring a comprehensive user experience through visual, tactile, and auditory cues. By combining these technologies, the proposed model offers an innovative solution for real-time posture correction, making yoga practice more effective and accessible for users without the need for an in-person instructor.

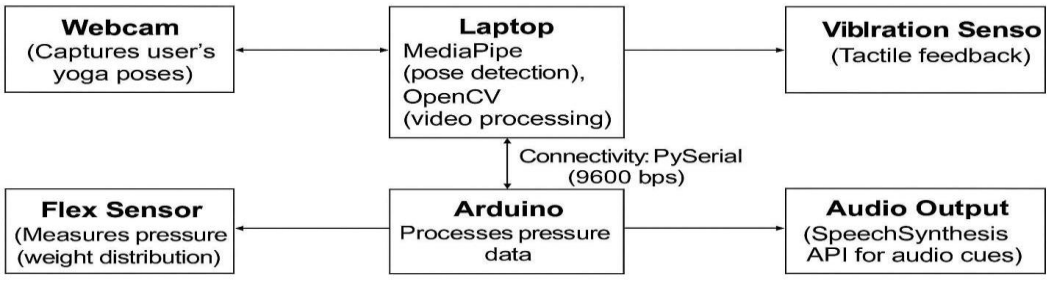

Fig 1. Block Diagram

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Table 1. Components & Specification

NAME OF THE COMPONENTS	SPECIFICATIONS	MODEL
NodeMCU ESP8266 / ESP 32	NodeMCU is an open source LUA based firmware developed for ESP8266 WiFi chip.	UNO R3
Computer Vision	Computer vision plays a pivotal role in the Real-Time Yoga Pose Detection and Feedback System, enabling the automated analysis of human posture through video input.	Laptop Camera
FLEX SENSOR	a pressure-based flex sensor as an optional tactile feedback mechanism to enhance posture correction, particularly in scenarios where visual or audio cues may be insufficient.	26.5mm X 48.5mm
LCD Display	LCD display as a visual feedback mechanism to provide practitioners with immediate insights into their yoga practice, enhancing usability in both individual and group settings.	16 X 2 or 20 X 4 LCD

NodeMCU ESP 8266 / ESP 32

NodeMCU is an open source LUA based firmware developed for ESP8266 WiFi chip. By exploring functionality with ESP8266 chip, NodeMCU firmware comes with ESP8266 Development board/kit i.e. NodeMCU Development board. Fig 2. shows the NodeMCU.

Fig 2. NodeMCU ESP 8266/ ESP32

LCD Display

An LCD screen can display useful information to the user such as the current command, system status or error messages. This feedback helps users understand the system's operation and troubleshoot any issues. Some systems incorporate audible alerts or LEDs to indicate status, providing feedback. Fig 3. Shows the LCD Display 2 x 16.

Fig 3. LCD Display 2 x 16

CAMERA (Computer Vision)

Computer vision plays a pivotal role in the Real-Time Yoga Pose Detection and Feedback System, enabling the automated analysis of human posture through video input. By processing live video streams, the system extracts critical data on joint positions and alignment, facilitating real-time feedback to enhance yoga practice safety and efficacy. Fig 4. CAMERA.

Fig 4. CAMERA

FLEX SENSOR (PRESSURE-BASED)

The Real-Time Yoga Pose Detection and Feedback System incorporates a pressure-based flex sensor as an optional tactile feedback mechanism to enhance posture correction, particularly in scenarios where visual or audio cues may be insufficient. This sensor detects pressure exerted during yoga poses, providing an alternative input for assessing alignment and triggering feedback. Fig 5. FLEX SENSOR.

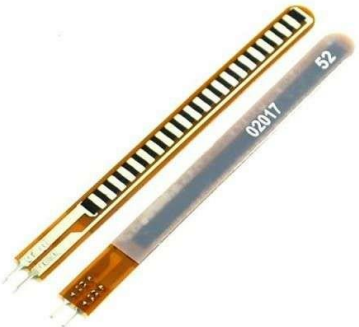

Fig 5. FLEX SENSOR

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WORKING PRINCIPLE

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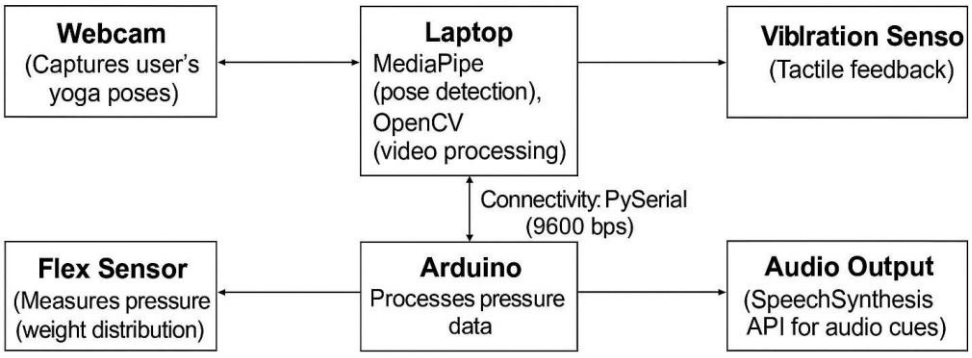

Fig 6.Block Diagram

Circuit Diagram

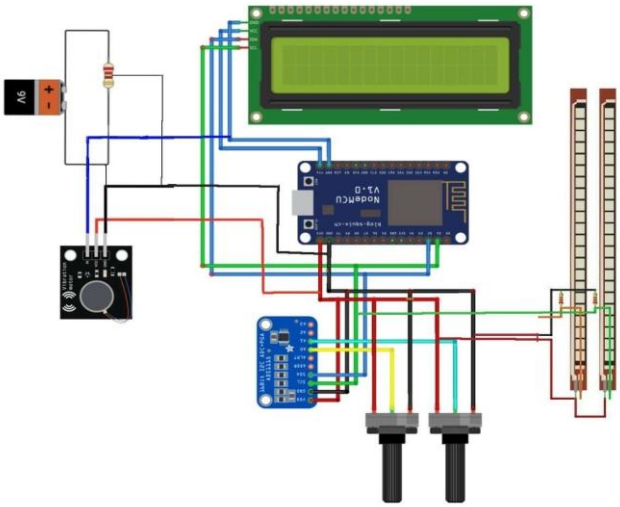

Fig 7. Circuit Diagram

RESULTS

The proposed model of our project is displayed below. Fig 8. Shows the proposed model

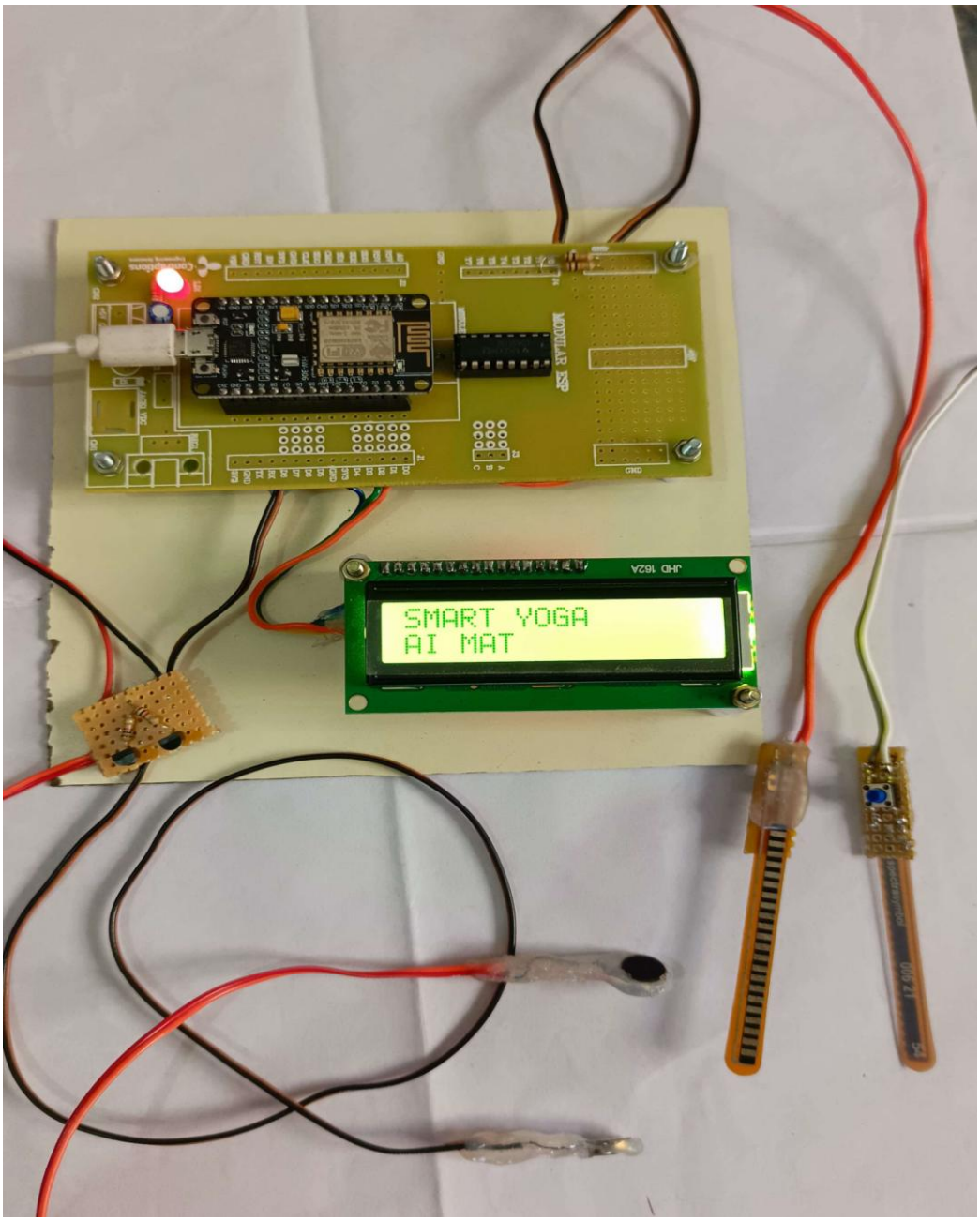

Fig 8. Proposed model

Open the App and give the command of the pick and place. The command will be displayed in the LCD.

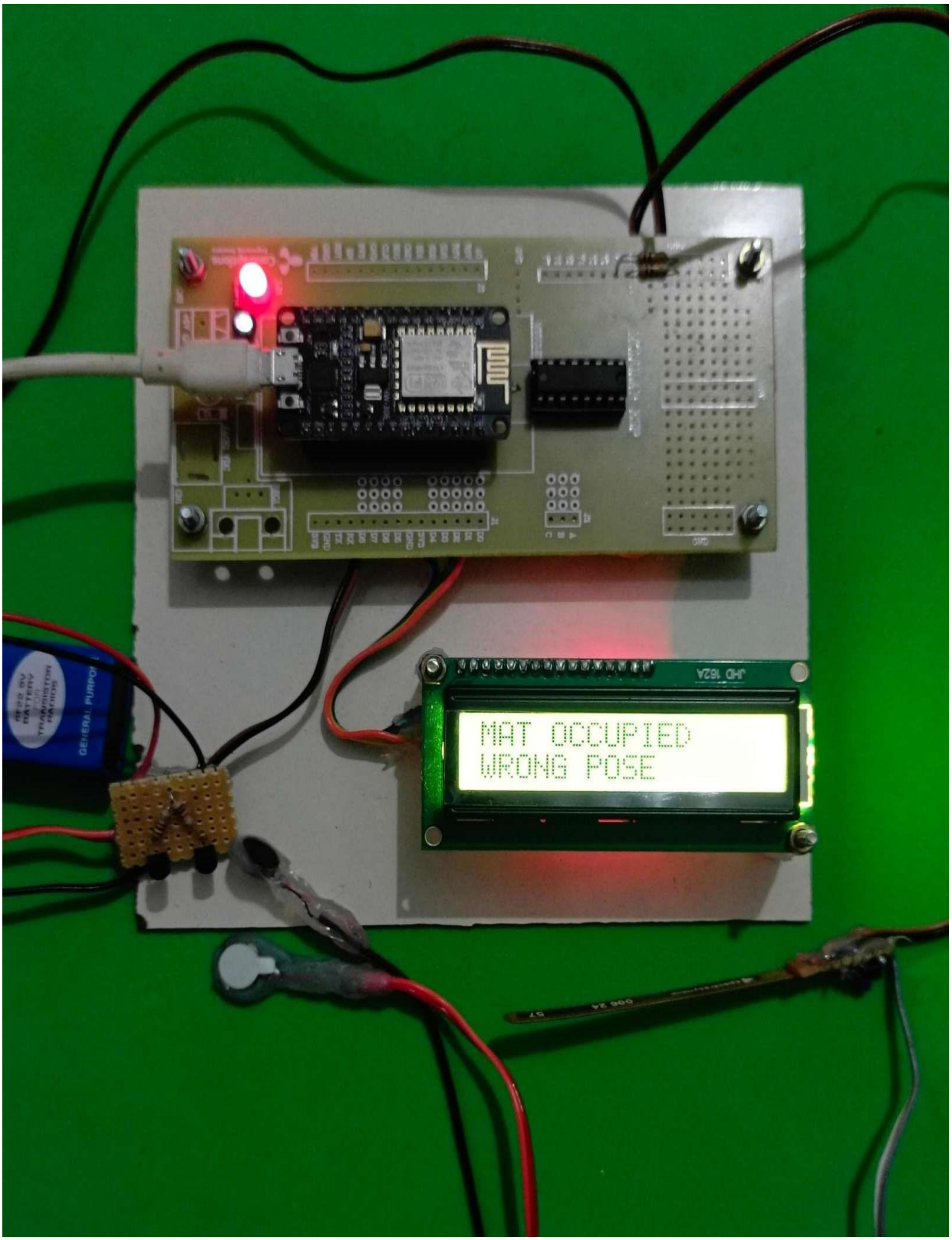

Fig 9. Command displaying in LCD

After that our model will pick the object and place the object. Fig 10. shows an object is picked.

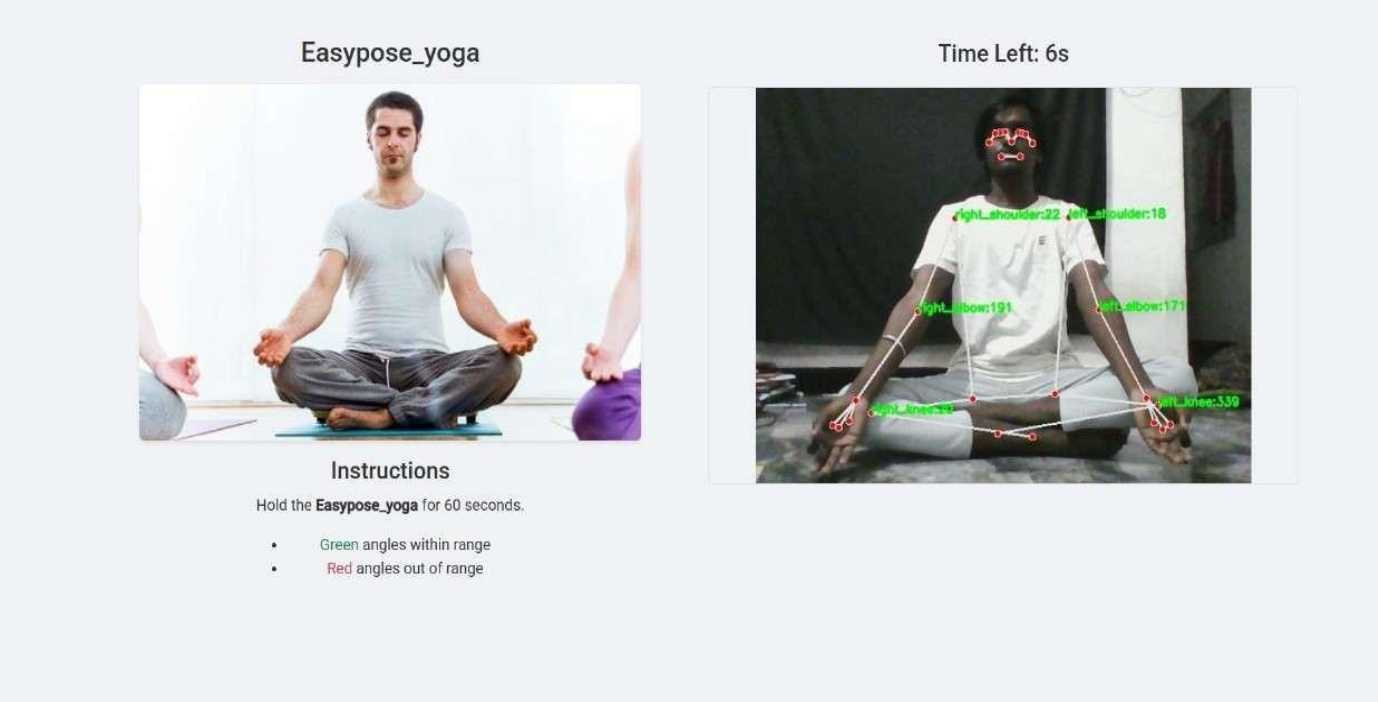

Fig 10. The webpage result

FUTURE WORK

The aspects implemented in this system not only provide practical solutions for yoga practitioners seeking realtime posture correction but also establish a foundation for future advancements in AI-driven fitness and wellness technologies. As we look ahead, our focus is on pioneering innovative approaches that address current limitations and set new standards for personalized yoga training and remote fitness guidance.

Advanced Technology Integration

Building upon the achievements of the current system, future efforts will focus on integrating advanced technologies to enhance performance and scalability. This includes exploring the potential of cloud-based IoT platforms like AWS IoT or Google Cloud IoT to enable remote storage and analysis of session data, facilitating progress tracking and personalized recommendations. Additionally, incorporating edge computing could optimize real-time video processing by offloading computations from the local device, ensuring smoother operation on resource-constrained hardware, while leveraging machine learning frameworks like TensorFlow could enhance pose recognition accuracy, creating a robust and future-proof system adaptable to diverse fitness applications.

CONCLUSION

The Real-Time Yoga Pose Detection and Feedback System effectively integrates computer vision and hardware technologies to provide a robust solution for posture monitoring and correction, significantly enhancing the quality of self-guided yoga practice. By leveraging a webcam for video input, MediaPipe and OpenCV for pose estimation and visualization, a Flask web interface for real-time user interaction, and an Arduino microcontroller (powered via laptop USB) with a pressure-based flex sensor and a 9-volt batterypowered vibration sensor for tactile feedback, the system delivers comprehensive visual, tactile, and audio feedback (“You done correctly” or “You done wrongly”) to users, achieving its objective of improving posture alignment and reducing the risk of injury. This implementation demonstrates the potential of combining AIdriven pose analysis with hardware integration to create an accessible and personalized yoga training tool, catering to practitioners of all levels and promoting safer and more effective yoga sessions without the need for an in-person instructor.

REFERENCES

[1]. Agrawal, Y., Shah, Y., & Sharma, A. (2021). "Implementation of Machine Learning Technique for Identification of Yoga Poses," IEEE 9th International Conference on Communication Systems and Network Technologies (CSNT), IEEE, vol. 8, no. 2, pp. 57-62.
[2]. Bansal, R., Sharma, R., Jain, P., Arora, R., Pal, S., & Vishal. (2024). "DeepYoga: Enhancing Practice with a RealTime Yoga Pose Recognition System," Engineering, Technology & Applied Science Research, vol. 14, no. 6, pp. 104-110.
[3]. Baruah, A., & Koti, V. M. (2023). "Machine Learning Based Yoga Recommendation System for Physical Fitness," Eighth International Conference on Science Technology Engineering and Mathematics (ICONSTEM), IEEE, vol. 3, no. 2, pp. 45-50.
[4]. Bharathi, S. V. S., Parasuraman, T., Akila, S., Ramakrishnan, R., Shivaraju, K., Krishnakumar, S., Sreedev, S. A., & Vijayalakshmi, C. (2024). "Yoga Poses Identification and Classification Based on Convolutional Neural Network and Transfer Learning with MediaPipe," International Research Journal of Multidisciplinary Technovation, vol. 6, no. 2, pp. 156-167.
[5]. Garg, S., Saxena, A., & Gupta, R. (2022). "Yoga Pose Classification: A CNN and MediaPipe Inspired Deep Learning Approach for Real-World Application," Journal of Ambient Intelligence and Humanized Computing, Springer, vol. 13, no. 7, pp. 93-98. 106
[6]. Jain, S., Rustagi, A., Saurav, S., Saini, R., & Singh, S. (2021). "Three Dimensional CNN-Inspired Deep Learning Architecture for Yoga Pose Recognition in the Real-World Environment," Neural Computing and Applications, Springer, vol. 33, no. 12, pp. 127-132.
[7]. Kavuri, R., Bangari, M., Yarram, H., & Talari, H. (2024). "Application of Artificial Intelligence on Camera-Based Human Pose Prediction for Yoga: A Methodological Study," Artificial Intelligence: Theory and Applications (AITA 2023), pp. 87-102.
[8]. Liaqat, S., Dashtipour, K., Arshad, K., Assaleh, K., & Ramzan, N. (2021). "A Hybrid Posture Detection Framework:
[9]. Integrating Machine Learning and Deep Neural Networks," IEEE Sensors Journal, vol. 21, no. 7, pp. 215-200.
[10]. Long, C., Jo, E., & Nam, Y. (2022). "Development of a Yoga Posture Coaching System Using an Interactive Display Based on Transfer Learning," The Journal of Supercomputing, Springer, vol. 78, no. 4, pp. 269-284.
[11]. Parashar, D., Mishra, O., Sharma, K., &Kukker, A. (2023). "Improved Yoga Pose Detection Using MediaPipe and MoveNet in a Deep Learning Model," Revue d'IntelligenceArtificielle, vol. 37, no. 5, pp. 197-202.
[12]. Saini, H. C. (2023). "iSartYogi: A Real Time Yoga Pose Recognition and Correction Feedback Model Using Deep Learning for Smart Healthcare," International Conference on Smart Systems for Applications in Electrical Sciences (ICSSES), IEEE, vol. 4, no. 2, pp.72-77.
[13]. Sakshi, & Saini, S. (2024). "Yoga Posture Estimation and Correction Using Mediapipe and Deep Learning Models," Data Science and Applications (ICDSA), vol. 6, no. 5, pp. 120-125.
[14]. Singh, K., Kumbhare, V. A., & Arthi, K. (2021). "Real-Time Human Pose Detection and Recognition Using MediaPipe," International Conference on Soft Computing and Signal Processing, Springer, vol. 6, no. 2, pp. 145154.
[15]. Sunney, J., Jilani, M., Pathak, P., & Stynes, P. (2023). "A Real-Time Machine Learning Framework for Smart Home-Based Yoga Teaching System," 7th International Conference on Machine Vision and Information Technology (CMVIT), IEEE, pp. 107-114.
[16]. Upadhyay, A., Basha, N. K., & Ananthakrishnan, B. (2023). "Deep Learning-Based Yoga Posture Recognition Using the Y_PN-MSSD Model for Yoga Practitioners," Healthcare, MDPI, vol. 11, no. 4, pp